Researchers unlock mystery of skin's sensory abilities

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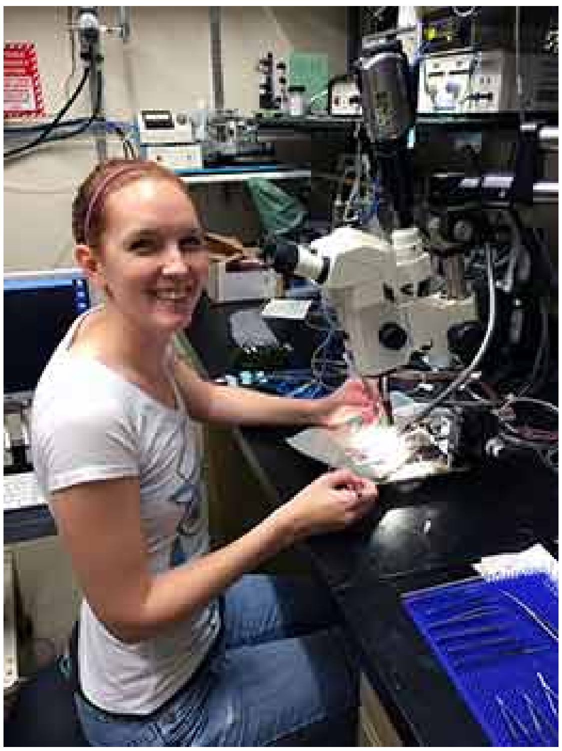

Colleen Cassidy, a UW doctoral student from Cheyenne, readies a mouse as part of her research on stimuli of the skin's senses. Cassidy and her professor, C. Jeffery Woodbury, contributed to a paper on the subject that appears in the Dec. 18 issue of *Cell*. Credit: C. Jeffery Woodbury Photo

Humans' ability to detect the direction of movement of stimuli in their sensory world is critical to survival. Much of this stimuli detection comes from sight and sound, but little is known about how the direction of movement of stimuli on the skin—humans' largest sensory organ—is detected and processed.

Until now.

For the past few years, two University of Wyoming researchers experimented with mice to discover some answers. C. Jeffery Woodbury, a UW associate professor in the Department of Zoology and Physiology, and Colleen Cassidy, a UW doctoral student from Cheyenne studying neuroscience, isolated various skin sensory cells from mice and recorded the responses of low-threshold mechanoreceptors, or LTMRs, on the skin. LTMRs are sensitive to innocuous skin indentation, stroking, vibration or stretch of the skin, and the deflection of hair follicles.

The neurological steps leading to the perception of touch begin with the activation of LTMRs, Woodbury says.

"These studies show that there are sensory neurons throughout the skin that are preferentially selective for movement in one direction versus another," he says. "That's not been documented before. Further, we also nailed down the mechanism for this directional selectivity. I think it (paper) will be a landmark in the field of sensory biology."

Woodbury was co-author —with David Ginty and other colleagues at Harvard University— of a paper, titled "The Cellular and Molecular Basis of Direction Selectivity of A delta-LTMRs," that appears in the Dec. 18 issue of *Cell*, the flagship journal of Cell Press, a pre-eminent international publisher of cutting-edge biomedical research and reviews. Cassidy also was co-author of the paper.

"We rely on our senses to understand our surroundings. These cells may give us awareness of movement of things on our body," Woodbury says. "There are many things in the skin senses that are unexplained."

For example, human skin feels which direction the wind is blowing or reacts to temperature, he says. Skin also provides information on whether something poses a threat, such as a mosquito, or a harmless midge.

Woodbury, Cassidy and their colleagues discovered that some sensory neurons innervate hairs, and their terminals glom on or attach to one side of the hairs as opposed to the other. They went on to show why, finding that this was due to communication between the terminal of the sensory cells and the cells that make up the follicles in the hair shaft, Woodbury says.

In separate experiments, they disrupted the signal so that this communication was gone. As a result, these sensory terminals migrated and wandered from their original position so that they now surrounded the hair shaft in a randomized pattern. This led to a randomization of the cell's response to the direction the hairs were moved, reducing their directional preference, Woodbury says.

Working with mice

"Our lab is like a hospital surgical suite," Woodbury says. "Everything is customized and miniaturized for what we do."

Mice were ideal to use for the research because their skin, like that of humans, contains more than 20 different types of sensory neurons. However, in mice, cells can be genetically engineered so that they are labeled by different-colored fluorescent proteins from jellyfish. The proteins were "turned on" in specific subsets of cells, so researchers could actually see these different types of sensory neurons that innervate regions of the mammals' skin, Woodbury says.

This cell isolation technique was used to record from these neurons while studying how they reacted to the direction of stimulus movement across the skin.

Cassidy has worked in Woodbury's laboratory since fall 2010. Her work on the Cell paper is part of her doctoral dissertation, she says.

"I've learned a lot of critical thinking and really how to approach a problem," she says. "I see different avenues and ways to answer questions. This research has taught me the value of perseverance. When you get that piece of data, it's really exciting since it is all about discovery."

"I don't think there are any studies out there that have really nailed down the entire process—from early developmental processes to highly specialized cells with specialized functions that, ultimately, play a direct role in perception," Woodbury says. "I think this work offers a rare view into development. Understanding how the brain sorts out and processes the movement of objects has been a central theme in neuroscience research."

Woodbury says he plans to explore the subject further, to determine whether skin stimulation affects heart regulation or other fundamental biological functions, such as pain processing.

"This research may have implications for controlling pain," Woodbury says. "For example, when someone pinches us, our first reaction is to rub the area, which helps reduce the pain. These findings suggest that it may have a greater impact depending on which way you rub it."

Provided by University of Wyoming